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Request for grant of a patent

1/77

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1.	Your reference	IMG/44112GB1
2.	Patent application number	08 JUL 2003 0315986.0
3.	Full name, address and post code of the or each applicant	Goss Graphic Systems Limited Greenbank Street Preston PR1 7LA Lancashire
	Patents ADP number	08669814001
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom
4.	Title of the invention	Printing Press
5.	Name of your agent	VENNER, SHIPLEY & CO
	"Address for service" in the United Kingdom to which all correspondence should be sent	20 LITTLE BRITAIN LONDON EC1A 7DH
	Patents ADP	1669004 ✓

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and the or each application number

Country	Priority application number	Date of filing

7. If this application is divided or otherwise derived from an earlier UK application, give the number and filing date of the earlier application

Number of earlier application	Date of Filing

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'YES' if:* *a) any applicant in 3. above is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body)*	YES

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Abstract	1
Drawing(s)	11 + 11

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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
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11. I/We request the grant of a patent on the basis of this application.

Signature: Venner, Shipley + Co.

Date: 8 July 2003

12. Name and daytime telephone number of person to contact in the United Kingdom: Ian Grey 020 7600 4212

Printing Press

Description

The present invention relates to a printing unit, a printing press and a folder used in such a press. One particular aspect of the invention relates to a modular flexible web-offset printing unit that enables the printed image cut-off to be varied in addition or alternatively to providing improved access to all parts of the unit for maintenance, repair and for setting up prior to initiating a new print run. Another aspect of the invention relates to a printing press and to the layout or orientation of the printing unit or units relative to a folder. A further aspect of the invention relates to the construction of a folder for use in a web-offset printing press.

A web-offset rotary printing press comprises a number of printing units designed to print matter onto separate continuous webs of a print medium, such as paper, travelling through each print unit. Each unit contains at least one pair of cylinder groups or print couples comprising a rotatably mounted plate cylinder, to which one or more printing plates are attached, and a rotatably mounted blanket cylinder. Many presses of this type incorporate a shaftless drive system in which each cylinder group is driven by its own drive motor which directly drives one of the cylinders of the group via a belt or gear drive. The cylinders within each cylinder group are typically coupled mechanically so that drive is transferred from the directly driven cylinder to the other cylinder of that group. An inking system associated with each print couple and comprising a train of ink rollers is operable to feed ink onto the printing plates as the plate cylinder rotates. As the cylindrical surfaces of the plate and blanket cylinder are in rolling contact, an inked image is transferred onto the blanket cylinder from the plate cylinder and, from the blanket cylinder, to the print medium generally comprising a web of paper passing between the blanket cylinder and an impression cylinder. To enable the paper web to be printed on both sides, the impression cylinder is actually the blanket cylinder of another print couple including a plate cylinder having printing plates to which ink is transferred from another inking system roller train. Therefore, it will be appreciated that a print couple is arranged on opposite sides of the paper web which runs between them.

Each printing unit comprises a frame to which each print couple and its respective inking system are mounted. The printing unit may also comprise a dampening system associated with each inking unit also mounted to the frame. The printing units are spaced from each other and aligned with a folder unit so that the paper web is fed through each print unit from a separate reelstand mounted below or to one side of each printing unit at floor level and then travels in a lateral direction away from the unit and into the folder. A slitting mechanism for cutting the web into separate ribbons and turner bars for turning one or more of the ribbons to orientate them before they enter the folder are located between the print unit and the folder.

In large scale high volume presses used, for example, in the printing of newspapers, multi-colour printing is achieved by providing each printing unit with a number of printing couple pairs mounted vertically one above the other in a stack so that the paper web travels in a vertically upward direction between each pair of print couples from the reelstand. A unit having four printing couple pairs, i.e. eight print couples, is able to print up to four colours on each side of the paper web and is often known as a "four-high" unit. A unit having a different number of print couple pairs is also possible depending on the application to which the press is to be put and the quality and number of colours to be printed. For example, a "five-high" unit having five print couple pairs is also known. When a printed web emerges from the upper end of each print unit it is passed over a roller having an axis of rotation at right angles to the direction of travel of the web. As the web passes over the roller its upward direction of travel is changed so that it now travels in a lateral direction along the press and towards the folder. Depending on the configuration of the press, the webs are slit and turned by passing them over turner bars angled at 45 degrees to the direction of travel of the web before they enter the folder, as will be explained in more detail below.

In conventional presses, each printing unit has a plate and a blanket cylinder with a fixed diameter. It will be appreciated that the diameter of these cylinders dictates the printed image cut-off which is the maximum length of the image that can be printed by the printing unit. In a one-around press or a press in which the image to

be applied to one page is transferred to the blanket cylinder in one revolution of the plate cylinder, the maximum length of the printed page cannot exceed the circumference or slightly less than the circumference of the plate and blanket cylinders or, in a two-around press, where the image to be applied to two pages is transferred to the blanket cylinder in one revolution of the plate cylinder, the maximum height of the printed page cannot exceed half the circumference of the cylinders.

It is a very difficult and time consuming task to alter the cut-off because it is fundamental to the size and geometry of the printing and folding machines and essentially involves changing the plate and blanket cylinders for cylinders of a different diameter as well as replacing or altering the position of many of the other components of the printing unit or press, including the cylinders of the folder which cut the webs into each copy and must change size to vary the cut-off, i.e. the length of the copy that the webs are cut into. This generally necessitates a complete strip-down and reassembly of the or each printing unit and the folder. Not only is this a very expensive operation to perform but it is particularly undesirable because it involves a considerable amount of time during which the press remains inoperable. Consequently, this has a significant negative affect on the overall productivity of the press. In fact, many press operators simply cannot afford to shut down the press for such lengthy periods of time due to increased demand for printed matter and the very tight deadlines which must be met. Therefore, the printed image cut-off achievable with a particular printing press is generally regarded as being fixed so the size of the newspaper that can be printed using that press is limited. The inability to change the cut-off of a conventional press, or the inability to do so rapidly and easily, has severely limited the desired flexibility that this type of press would otherwise be able to offer. Press manufacturers therefore have to offer different presses, including printing units and folders, in a range of specific cut-off sizes to meet customer demand.

In addition to the problems described above, a conventional printing press also suffers from a number of other disadvantages that reduces its operational time and hinders its flexibility. Very short deadlines and high demand often means that the

press must be run continually over long periods of time. However, delays occur due to the time it takes for the press to be made ready for a new print job when the previous print job has been completed. For example, to plate-up the press, individual printing plates on each printing cylinder of each printing couple must be replaced. This is a time consuming task especially as access to the plate cylinders may be limited by other components such as the inking and/or dampening mechanism which get in the way. It will also be appreciated that in a four high printing unit, the printing plates may need to be replaced on eight plate cylinders before initiating a new print run with that printing unit. In addition, the press may comprise several printing units all of which require plating-up before initiating a new print run using all the printing units. Experience has shown that it can take at least 45 minutes for one person to replace the printing plates on a single four-high printing unit.

It will also be appreciated that individual printing units or specific couples within each unit require regular attention for the purposes of maintenance and/or repair. However, the inaccessibility of certain components means that the printing unit often has to be stripped down to gain access to the failed component or for cleaning and this significantly increases the down time of the press.

The aforementioned problems are exacerbated by the structural height of each printing unit making access to the higher print couples and their associated components for plating-up and maintenance even more complicated in addition to requiring larger and more expensive buildings to contain them. Furthermore, as the print couple pairs are stacked one above the other, the paper web to be printed must travel over a comparatively long distance between points at which different coloured ink are printed onto the web. This can lead to problems in maintaining registration of the printed image and increases waste when the press is stopped, during plate changes and when the press is restarted. It will also be noted that a printing unit of greater height has a corresponding increase in weight and structural instability requiring the foundations of the press to be more heavily reinforced. Although problems caused by the height of the press and the distance between points at which the different coloured inks are printed onto the web can be

alleviated by the use of a satellite press in which a number of cylinder groups are arranged around a central impression cylinder, this type of press is mechanically very complicated and requires regular maintenance.

One aspect of the present invention also addresses the problem of maintaining equal tension in the web when it has been slit to form two or more separate ribbons and one or more of the ribbons is moved by passing it over turner bars so that they can be fed over the same former in the folder. Ideally, the tension in each ribbon is kept the same and remains constant. However, this is very difficult to achieve in practice, especially when the direction of one or some of the ribbons is changed more than the direction of other ribbons because of the friction generated between the ribbon and a turner bar as the ribbon slides over it. It will be appreciated that a constant and equal web tension is important from the point of view of both maintaining registration in the printed image across the page and achieving good press runability with a minimum of web breaks. This problem and the proposed reconfiguration of the press to alleviate or solve it will be addressed further below.

It is an object of the present invention to overcome or substantially alleviate the problems with a conventional printing unit, press and/or folder, many of which have been described in more detail above. Many of the modifications proposed by the invention can be used independently to overcome some of the aforementioned problems. However, it is also envisaged that the modifications can all be employed together in the same press to maximise the overall flexibility such a press would provide.

According to a first aspect of the invention, there is provided a printing unit for a web-offset press comprising plate and blanket cylinders arranged in couples to print on both sides of a paper web passing between each pair of print couples, and an inking system associated with each print couple when the printing unit is in an operative position operable to supply ink to the plate cylinder thereof, wherein the printing unit is separable into a primary module carrying the plate and blanket cylinders and a pair of secondary modules carrying the inking systems.

In a preferred embodiment, the printing unit includes means to enable the primary module to be replaced with a different primary module when the or each printing unit has been separated so that each inking system of the secondary modules will be associated with a respective print couple of said different primary module when the or each printing unit is returned to its operative position.

The present invention also comprises a method of reconfiguring a printing unit comprising plate and blanket cylinders carried by a primary module and inking systems carried by a pair of secondary modules, an inking system being associated with each print couple when the printing unit is in an operative position, the method comprising the steps of separating the secondary modules from the primary module and replacing the primary module with a different primary module.

In accordance with another aspect of the invention, there is provided a folder for a web-offset printing press comprising an upper folder module including at least one former to impart a first longitudinal fold to a continuous web of printed matter passing over the or each former, a lower folder module to receive the folded web from the upper folder module and comprising means to cut the web into longitudinal sections and impart a second fold to each section substantially at right angles to the first longitudinal fold and, a delivery module comprising means to receive the folded sections from the lower folder module and deliver them for transportation out of the folder, wherein the lower folder module is separable from the upper folder module.

In accordance with another aspect of the invention, there is provided a folder for a web-offset printing press comprising an upper folder module including at least one former to impart a first longitudinal fold to a continuous web of printed matter passing over the or each former, a lower folder module to receive the folded web from the upper folder module and comprising means to cut the web into longitudinal sections and impart a second fold to each section substantially at right angles to the first longitudinal fold and, a delivery module comprising means to receive the folded sections from the lower folder module and deliver them for

transportation out of the folder, wherein the delivery module is separable from the lower folder module.

The present invention also provides another method of reconfiguring a folder for a web-offset printing press comprising an upper folder module including at least one former to impart a first longitudinal fold to a continuous web of printed matter passing over the or each former, a discrete lower folder module separable from the upper folder module to receive the folded web from the upper folder module and comprising means to cut the web into longitudinal sections and impart a second fold to each section substantially at right angles to the first longitudinal fold and, a delivery module comprising means to receive the folded sections from the lower folder module and deliver them for transportation out of the folder, wherein method includes the step of separating the lower folder module from the upper folder and the delivery modules and replacing the lower folder module with another lower folder module.

According to another aspect of the invention, there is provided a web-offset printing press comprising a print unit and a folder located adjacent to the print unit together defining a path for a web of paper passing through the press, the print unit comprising means for slitting the web to form a plurality of ribbons and means for turning said ribbons so that each lie in a parallel plane one above the other as they travel towards and into the folder, wherein the press is configured such that said means for turning the ribbons is operable to turn each ribbon the same number of times between the print unit and the folder.

Embodiments of the invention will now be described, by way of example only, with reference to Figures 1 to 3, 5 to 8 and 10 to 13 of the accompanying drawings, in which:

FIGURE 1 illustrates a side cross-sectional elevation of a printing unit in a closed or operative position ready for printing according to the invention;

FIGURE 2 illustrates a side cross-sectional elevation of the printing unit shown in Figure 1 but in a partially open non-operative position to facilitate maintenance or plating up operations;

FIGURE 3 illustrates a plan view of one print unit having two primary modules according to the modified version of the print unit illustrated in Figures 1 and 2.

FIGURE 4 illustrates a plan view of a conventional press configuration;

FIGURE 5 illustrates a plan view of a press configuration according to the invention;

FIGURE 6 illustrates a plan view of an alternative press configuration according to the invention;

FIGURE 7 illustrates a simplified side elevational view of a folder according to an aspect of the invention;

FIGURE 8 illustrates a simplified plan view of the lower folder module, the delivery module and a replacement lower folder module;

FIGURE 9 illustrates a perspective view of part of a web path from one print unit to the folder according to a conventional arrangement;

FIGURE 10 illustrates a perspective view of part of a web path from one print unit to the folder according to another aspect of the invention;

FIGURE 11 illustrates a plan view of a proposed printing press configuration incorporating printing units according to one aspect of the invention;

FIGURE 12 illustrates an alternative printing press configuration; and

FIGURE 13 illustrates yet another alternative press configuration.

Referring now to the drawings, there is shown in Figure 1 a side cross-sectional elevation of a printing unit 1 according to the invention which is illustrated in its operative or printing position ready for use. A web offset press of the invention may comprise one or several of these units each aligned so as to work in unison with a paper web passing through each printing unit 1 into a folder (not shown).

The illustrated printing unit 1 is of a four-high configuration for four colour printing on both sides of the web. It therefore has eight print couples each comprising a plate cylinder 2 and a blanket cylinder 3. Each print couple is arranged in a pair disposed on opposite sides of the paper web 4 which runs between them so that the web 4 can be printed on both sides at the same time as it passes up through the print unit 1 from a reelstand (not shown) which may be mounted below or to one side of the print unit 1 at floor level.

An inking system 5 and a dampening system 6 is operatively associated with each print couple or, more specifically, the plate cylinder 2 of each print couple so as to supply ink and dampening solution thereto for printing. The inking and dampening systems 5,6 each comprises a train of rollers including forme rollers and ink distribution rollers. As the inking and dampening systems 5,6 are well known, no further description of their construction need be made here.

The printing unit 1 comprises a primary or central module 7 disposed between a pair of secondary or outer modules 8,9. The modules 7,8,9 are each mounted on a frame. As can be most clearly seen from Figure 2, which illustrates the printing unit 1 of Figure 1 in a non-operative partially open configuration for plate changing or maintenance, the plate and blanket cylinders 2,3 are rotatably mounted to the primary module 7 and the inking and dampening systems 5,6 are mounted to each of the secondary modules 8,9. Ideally, few other components apart from the plate and blanket cylinders 2,3 are mounted to the primary module 7 for reasons that will become apparent.

As can be seen from Figure 2, the secondary modules 8,9 are movably mounted so that they may retract or slide laterally away from the primary module 7 and so that the axis of the cylinders 2,3 mounted to the primary module remains parallel to the axis of the rollers of the inking and dampening systems 5,6 mounted to the secondary modules 8,9 but the axis-to-axis distance between them increases as the secondary modules 8,9 are moved laterally away from the primary module 7. However, only one secondary module 9 is shown retracted from the primary module 7 in Figure 2 but it will be appreciated that the other secondary module 8 may also retract to facilitate access to that side of the printing unit 1 as well.

As can be seen from the representation of a person 11 standing between the retracted secondary module 9 and the primary module 7 in Figure 2, the secondary modules 8,9 may retract laterally away from the primary module 7 by a distance which enables a person to walk between the secondary and primary modules 7,8,9 to carry out various tasks such as cleaning, maintenance or plating-up of the printing

unit either to the plate and blanket cylinders 2,3 in the primary module 7 or, to the inking and/or dampening systems 5,6 of the secondary modules 8,9.

As the printing unit 1 opens up, it will be appreciated that access to all the components of the unit 1 is significantly improved. Furthermore, in conventional printing units that do not open up in the way described, access to the plate cylinders 2 for plating up operations must be made available from the outside of the printing unit, i.e. between the inking and dampening systems 5,6. This means that an access space must be provided between a print couple and the one situated directly above it. It also means that the inking and dampening units 5,6 are arranged so that their configuration of rollers extends in an angled direction away from the axis of the plate cylinder.

In the present embodiment of the invention, and as access to the plate cylinders 2 is obtainable via the space between the primary and secondary modules 7,8,9 when the secondary modules 9 are separated from the primary module 7, access from the outside of the printing unit 1 between the inking and dampening systems 5,6 is no longer required. Consequently, the print couples can be positioned much closer together in the vertical direction and the inking and dampening systems 5,6 can be located so that they extend substantially in a lateral rather than angled direction away from the axis of the plate cylinders 2. Therefore, the overall height of the print unit 1 is considerably reduced.

The reduction in the overall height of the print unit 1 facilitates access to upper parts of the print unit 1 and also reduces the height of the building required to contain it. Furthermore, the weight of the unit 1 is considerably reduced so the need for heavily reinforced foundations is also reduced.

As the distance between the print couples is reduced, the distance that the web 4 has to travel between points at which each colour ink is applied thereto also leads to improvements in registration, a reduction in the fan-out effect of the paper web 4 as well as reducing paper waste when the print unit 1 is made ready or is stopped

between print runs or due to other problems requiring shut down of the print unit 1.

Each of the secondary modules 8,9 are mounted on a slideway such as rails (not shown) to enable them to be automatically and independently retracted from the primary module 7. The rails may extend laterally both under the printing unit 1 and above it and within the frame 10 in which the modules are slideably mounted. A motor or other driving means is mounted in each secondary module 8,9 to drive it between its operative and non-operative positions in response to remote actuation. Each secondary and primary module 7,8,9 may include means for locking them together when the secondary modules 8,9 are in their operative positions and the print unit 1 is ready for printing. When the secondary modules 8,9 are moved back into their operative positions, they will automatically and accurately locate with their inking and dampening systems 5,6 associated with the plate cylinders 2 in their correct positions ready for printing.

Although the print unit 1 has been described as having secondary modules 8,9 which retract sufficiently to enable a person 11 to gain access between each secondary module 8,9 and the primary module 7, it will be appreciated that it is not necessary to provide means to enable the secondary modules 8,9 to move to such an extent. For example, when an automatic plate changing mechanism is employed, the secondary modules 8,9 only need to move a distance from the primary module 7 sufficient to enable the plate changing mechanism to pass between each secondary module 8,9 and the primary module 7. It is envisaged that the plate loading mechanisms will also be fully automatic and can deliver a set of plates to each print unit and install them automatically. The plates will be loaded into automatic plating up modules off-line which will then be delivered to the press either manually or by an automatic transportation system. The plate changing modules will locate themselves between the primary and secondary modules 7,8,9 and install the plates onto the cylinders automatically. Similarly, other robotic or automatic sub-systems may be employed such as automatic cleaning to clean both the blankets and the ink trains, unit setting machines capable of checking forme roller to plate cylinder flat settings or on-press imaging systems capable of introducing direct imaging to the

plate cylinders. These automatic modules may therefore avoid the need to move the secondary modules 8,9 by a distance sufficient to enable a person to gain access between the secondary and primary modules 7,8,9. It is also envisaged that on-press imaging technology may be employed to laser engrave a re-writable plate on the cylinder. As access to the plate cylinder 2 is made easy when the inking and dampening systems 5,6 are moved out of engagement with the plate cylinder 2, the engraving equipment can be located in the space between the primary and secondary modules 7,8,9 and subsequently removed before the secondary modules 8,9 are returned to their operative positions.

The ability to split the printing unit 1 also simplifies the construction and therefore the cost of many of the sub-systems referred to in the previous paragraph because they no longer need to be designed so that they can access, for example, the plate cylinders between other components of the printing unit such as the inking and dampening systems.

As an alternative to moving each of the secondary modules 8,9 laterally away from the primary module 7 in opposite directions, it will also be appreciated that the printing unit 1 could be arranged so that only one secondary module 9 and the primary module 7 move laterally away from the remaining secondary module 8 in the same direction so as to separate the primary and secondary modules 7,8,9.

A further modification of the printing unit according to the aforementioned embodiment of the invention will now be described. This modified embodiment enables the plate and/or blanket cylinders to be changed quickly and easily for cylinders of the same or different diameters thereby enabling the printed image cut-off to be changed. As the cut-off depends on the diameter of the plate and blanket cylinders, they must be replaced with cylinders having a different diameter to enable the cut-off to be altered to suit the required print job. In addition to facilitating the alteration of the printed image cut-off by changing the plate and blanket cylinders, this modification also simplifies general maintenance and other tasks such as plating up, changing blankets and setting rollers.

Rather than physically remove the plate and blanket cylinders from the primary module, the present invention realises that because the unit separates into three modules, one of which contains the plate and blanket cylinders and very few or no other major components of the printing unit, it is possible to replace the primary module as a whole with another primary module stored off-line by moving it, when the secondary modules are in their retracted non-operative positions, and replacing it with another primary module, using either an automatic or manual transportation system. The new module can have an entirely different set of plate and blanket cylinders. However, the secondary modules containing the inking and dampening systems are reused with the new primary module and can be moved back so that the inking and dampening systems become operatively associated with the plate cylinders of the new primary module so that the printing unit is rapidly made fully operational again. The old primary module is now stored off-line until its use is required once again or it is moved into an appropriate location for maintenance, repair or plate changing.

To enable the primary module to be moved or changed, it is mounted on a slideway such as on rails so that it can be slid from a first position in which it can be operatively associated with the secondary modules for printing to a second storage or maintenance position off-line in which it is no longer between the secondary modules. The primary module may be movable in a lateral direction which is substantially at right angles to the lateral direction of movement of the secondary modules when they move between their operative and non-operative positions. The printing unit may be arranged so that as one primary module is moved out of its printing position another module stored off-line moves between the secondary modules so as to take its place.

It will be appreciated that as the whole primary module is completely replaced with a different module, the printing unit can be quickly and easily brought back on-line as soon as the secondary modules have been returned to their operative positions. Therefore, maintenance, plate changing or cleaning of one primary module can be carried out whilst the printing unit is operational with another primary module.

It will be appreciated that each printing unit may be provided with two or more primary modules. Alternatively, a printing press employing a number of printing units may be provided with any number of primary modules which may be stored off line either adjacent to the press or in a magazine rack alongside the press. Depending on the layout of the track to which the primary modules are mounted, they may be moved, for example, between one or more printing units or taken into another room for more in-depth maintenance or setting up. It will be apparent that in an ideal configuration, the press is provided with a larger number of primary modules than there are print units so that it will always be possible to keep the entire press running even when one or more modules is off-line for maintenance and repair.

When this modified arrangement is used, it will be appreciated that the secondary modules need only move laterally away from the primary module by a distance sufficient to enable the primary module to move out from between the secondary modules as any maintenance to the primary and/or secondary modules can be conducted once the primary module has been moved. However, it may be preferable to enable the secondary modules to move by a greater distance to enable maintenance and other tasks to be carried out whilst the primary module remains in situ.

A plan view of one print unit having two primary modules 7a,7b according to the modified version of the invention is illustrated in Figure 3. In this simplified arrangement, it can been seen that the secondary modules 8,9 are configured so that they can each move from their operative positions laterally away from the primary module 7a in opposite directions (the secondary module 8 moves in the direction indicated by Arrow A, whereas the other secondary module 9 moves in the direction indicated by Arrow B) so that they become separated from the primary module 7a. Once the primary module 7a is free from the secondary modules 8,9, the primary module 7 itself can then slide out from between the secondary modules 8,9 to the position shown in dashed lines (the primary module 7a moves in the direction indicated by arrow C). At the same time or after movement of the primary module 7a, an additional primary module 7b located off-line takes the place of the primary

module 7a by also moving in the direction of arrow C. The secondary modules 8,9 can then be moved back so that they operatively engage with the new primary module 7b. The print unit 1 can then be operated with the additional primary module 7b whilst the maintenance, plating up, cleaning or other tasks are performed on the now off-line primary module 7a.

Although this aspect of the invention is primarily concerned with the ability to substitute the primary module, it is also envisaged that the printing unit or press may include at least one spare secondary module usually stored off-line and which can be substituted for a secondary module in an operative position in the press so that maintenance or repair to a secondary module can be carried out whilst the printing unit continues to operate with another secondary module.

It will be appreciated that in a printing press having a number of printing units, all of the units may have a similar configuration. In a more complicated arrangement, each printing unit may have several primary modules associated with it so that one can be selected depending on the print task to be carried out and the printed image cut-off required. Alternatively, the press may be provided with a plurality of primary modules any one of which may be used with any one of the print units of the press.

As already mentioned above, the folder must also be modified each time a primary module is changed for another primary module having cylinders operable to print with a different image cut-off. As can be seen from Figure 7, a folder generally comprises three sections namely, an upper folder module 50, a lower folder module 51 and a delivery module 52. The upper folder module 50 comprises at least one former 53 (two are shown in Figure 7) which imparts a first longitudinal fold to the ribbons 54 as they travel over it and a plurality of nipping rollers 55. There are generally two different types of lower folder and these are usually referred to as a jaw folder and a rotary folder, respectively. A jaw folder, as shown in Figure 7, comprises a collect cylinder 56 to collect the ribbons 54 as they leave the or each former 53, a cutting cylinder 58 which cuts the ribbons 54 into longitudinal sections defined by the height of the page and a jaw cylinder 57 which imparts a second fold to the cut sections substantially at right-angles to the fold imparted to the ribbons

54 by the or each former 53. A rotary folder (not shown) comprises a folding cylinder and second fold rollers together with a cutting cylinder to perform the same function.

The cut sections or newspapers pass from the folder module 51 into the delivery module 52 comprising a rotatably mounted paddle wheel 59 which delivers the newspapers to a conveyor 59a with an appropriate copy spacing for stacking and bundling by post-press machinery. The delivery module 52 also includes a stripper (not shown) situated between the paddle wheel 59 and the conveyor 59a which runs slower than the paddle wheel but at the same speed as the conveyor 59a. The stripper pushes copies out of the paddle wheel 59 and onto the conveyor 59a.

The cylinders 56,57,58 of the lower folder module 51 are all cut-off dependent which means that when the cut-off is changed, each of the cylinders 56,57,58 must be replaced with cylinders having a different diameter corresponding to the new cut-off. Therefore, if the primary modules 7 of the printing units are replaced to alter cut-off, the cylinders 56,57,58 of the lower folder module 51 must also be replaced.

Therefore, according to another aspect of the invention, rather than physically remove the cylinders from the lower folder module 51 and replace them, the lower folder module 51 is configured to be discrete and separable from the upper folder module 50. The lower folder and delivery modules 51,52 may be combined into one integral or common frame. However, more preferably, the delivery module 52 is also discrete and separable from the lower folder module 51. The delivery module includes the paddle wheel 59 and, preferably, includes the stripper and the conveyor. However, it may just comprise the paddle wheel 59.

Therefore, as with the primary module 7 of each of the printing units 1, the lower folder module 51 together with its cylinders 56,57,58 forms an entirely separate part which may be removed from the folder as a whole and replaced with another folder module 60 (see Figure 8) stored in an off-line location and which may be assembled together with cylinders 56,57 having a diameter corresponding to the required new

cut-off size. The lower folder module 51 and the delivery module 52 may be mounted on slideways to enable them to be moved between operative positions in the folder and non-operative off-line positions. In the plan view of Figure 8, the lower folder module 51 is shown in its operative position in which it is connected to the upper folder module 50 (not shown in Figure 8) and to the delivery module 52. The lower folder module 51 can be separated from the folder and moved in the direction indicated by arrow Y to an off-line storage position shown in dashed lines and can be replaced with another lower folder module 51a by moving it in the direction indicated by arrow Z.

If the folder comprises a delivery module 52, the same delivery module 52 can be used with any lower folder module 51 irrespective of its cut-off size and even with folding modules that use different folding actions. It is also much easier to alter the relative position of the lower folder module 51 and the delivery module 52 to optimise the transfer of copies from the lower folder module 51 to the delivery module 52. The lower folder module 51 and the delivery module 52 each have their own side frames 65,66 to which the components of the respective module 51,52 are mounted. Preferably, the side frames 66 of the delivery module 52 are spaced closer together than the side frames 65 of the lower folder module 51 so that the delivery module 52 can be slid partially inside the lower folder module 51 in its operative position. The delivery module 52 can also be easily slid out of engagement with, or retracted away from, the lower folder module 51 to facilitate access to the lower folder module 51 and the delivery module 52 for maintenance and repair or replacement of one or both of them.

It will be appreciated that the paddle wheel 59 and stripper of the delivery module 52 delivers copies to the conveyor 59a with a predetermined fixed copy spacing for stacking and bundling by post press machinery. However, various customers often require copies to be delivered with different copy spacing. To change the copy spacing of a conventional folder, the paddle wheel 59 and stripper must be substituted for another of a different configuration. However, in the present invention, instead of having to disassemble the delivery module 52 to replace the paddle wheel 59 and stripper, the whole delivery module 52 can be quickly and

easily replaced with another module 52 having a paddle wheel capable of delivering copies with the required copy spacing.

It is common practice to install a back-up lower folder next to a primary lower folder so that in the event of a failure of one unit, production can be switched to the other. If the folder is provided with a separable delivery module 52, only one delivery module 52 is required and can be used with either of two lower folder modules 51. Alternatively, if there are two delivery modules 52, each delivery module 52 can be used with either lower folder module 51.

It will be appreciated that some of the aforementioned advantages such as access to the lower folder unit and substitution of the delivery module 52 can be achieved without the need for a separable lower folder module 51. Therefore, in accordance with another aspect of the invention, there is a folder having an integral upper and lower folder comprising modules 50,51 and only the delivery module is separable from the rest of the folder. In either arrangement, it is proposed that the delivery module 52 incorporates its own motor for driving the paddle wheel 59 and, preferably, the stripper and the conveyor.

A printing press according to another aspect of the invention will now be described. The press according to this aspect of the invention may be used with the printing units and folder described with reference to the earlier embodiments. However, it will be appreciated that the following press configuration may also be employed with other conventional printing units, presses and folders.

In order to describe this aspect of the invention, a simplified plan view of a conventional press layout is illustrated in Figure 4. It can be seen, for the purposes of this embodiment, that the press comprises four print units 13a,13b,13c and 13d and a folder 14 having two formers 14a and 14b. A pair of print units are located on opposite sides of the folder 14 and the paper web from each print unit 13a to 13d travels upwardly through each print unit 13a to 13d and then laterally across (as indicated by the arrows X) and then down into the folder 14 via a slitting mechanism (not shown) to cut the web into separate ribbons travelling side by side

and a turner bar module 15 which is used to turn one of the ribbons so that both ribbons overlap and enter the same former 14a or 14b of the folder 14. The uppermost pair of print couples each comprising a plate and blanket cylinder 2,3 can be seen in each print unit 13 from which it will be apparent that the plane of the web as it emerges from the print unit and the plane of the web as it enters the folder 14 are parallel.

The problem with a printing press configured in accordance with the illustration has already been mentioned above and occurs when the web is slit so as to form a plurality of ribbons which must then be fed through the same former 14a or 14b in the folder 14, as opposed to each ribbon being fed through a separate former to form two or more separate newspaper sections side-by-side. When the web is slit, the ribbons so formed are travelling together in the same plane in a side-by-side relationship. Therefore, the relative positions of the ribbons must be changed so that they are no longer travelling in the same single side-by-side plane but instead travel in different parallel planes lying one above the other or in an overlapping relationship. Although the relative positions of the ribbons are changed by the turner bars 15 disposed adjacent to the folder 14 not all of the ribbons are turned or not all of them are turned the same number of times. It therefore becomes very difficult to control the web tension in each ribbon. Any differences in web tension between the ribbons makes it difficult to ensure that the ribbons remain in register. The alignment or registration of the ribbons is important, particularly so when so-called "split double" printing is carried out and in which a photograph or other matter is printed so that it extends across two separate pages of a tabloid newspaper each of which may be on a different ribbon.

The modified arrangement is illustrated in Figure 5 from which it can be seen that each of the print units 13a to 13d have been turned through 90 degrees so that the plane of the web as it travels in a vertically upward direction through each print unit 13 is at right angles to the plane of each of the ribbons as they travel downwardly into the folder 14 through one of the formers 14a or 14b, as will be apparent from the position of the uppermost pair of plate and blanket cylinders 2,3. As will be explained, turner bars 15 are used to turn the plane of all the ribbons through 90

degrees so that they are aligned with the folder 14 and travel in the direction indicated by the arrows X2 in Figure 5. A slitting mechanism and turner bar module is mounted on and directly above each print unit 13 so that the web is slit and turned soon after it exits each print unit rather than just before the ribbons enter the folder. The turner bar module or slitting mechanism are not shown in Figure 5 for clarity. Alternatively, the turner bars 15 and slitting mechanism (not shown) may be located adjacent to each print unit 13 so that the webs are turned to be in line with the folder 14 which is offset from the print units 13, as shown in Figure 6, and in which the movement of the web from each print unit 13 to the folder is indicated by the arrows X3.

Reference to the prior art arrangement of Figure 9 of the accompanying drawings will now be made together with Figure 10 which illustrates the modified arrangement according to the invention. For simplification, the web in both drawings has been slit once so as to form two separate ribbons. However, it will be appreciated that the web may be slit any number of times as required.

Referring to the generalised perspective view of Figure 9, a section of the web 4 can be seen travelling in a vertically upward direction (in the direction of arrow F) as it leaves the print unit (not shown). The web is passed over a roller 16 whose axis is parallel to the plane of the web 4 and which turns the web 4 through 90 degrees so that it is now travelling in the direction indicated by arrow G in a lateral direction which is directly towards the folder 14.

A mechanism 17 for slitting the web so as to form two separate ribbons 18,19 travelling side-by-side is disposed adjacent to the folder 14. Once the web 4 has been slit, one of the ribbons 19 is passed over a pair of further rollers 20,21 both of which have their axes parallel to the plane of the ribbon 19 so that the ribbon 19 travels in a downward direction and then in a lateral direction once again in the directions indicated by arrows H and I respectively. The same ribbon 19 is then passed over first and second turner bars 15a,15b having their axes at 45 degrees to the plane of the ribbon 19. When the ribbon 19 has passed over the second turner bar 15b, it can be seen that it is now travelling directly beneath in a parallel plane

and in the same direction as the remaining ribbon 18 which remains on the same path after passing over the first roller 16. Therefore, as one ribbon 19 is passed over rollers 20,21 and turned twice over turner bars 15a,15b whereas the other ribbon 18 passes straight into the folder 14 without being turned, the relative tension between the two ribbons 18,19 is likely to be different leading to well-known runability and registration problems.

The present invention overcomes this problem and provides an arrangement in which the ribbons are positioned in parallel planes one above the other by ensuring that both the ribbons are turned the same number of times. Referring to Figure 10, the web 4 can be seen travelling in a vertically upward direction from the print unit in the direction of Arrow F as before. However, as described with reference to Figure 5, the print unit has been rearranged so that the plane of the web 4 now lies at an angle of 90 degrees relative to the plane of the ribbons as they enter the folder 14.

As the web 4 travels in its vertically upward path from the print unit, it is slit by a slitting mechanism 17 to form two ribbons 22,23 both travelling vertically side-by-side in the same plane. Each ribbon 22,23 is then passed over separate rollers 24,25 at different heights both of which have their axes at right angles to the direction of travel of the ribbons 22,23. As the ribbons 22,23 pass over the rollers 24,25 they are turned through 90 degrees so that they are now both travelling in a lateral direction side by side but at different heights in the direction indicated by arrow J. Both ribbons 22,23 now need to be turned so that they are travelling towards the folder 14. This is achieved by passing each ribbon 22,23 over a turner bar 26,27 having their axes aligned at 45 degrees to the direction of travel of each ribbon 22,23. The lower turner bar 26 is located in front of but lower than the upper turner bar 27 so that when the ribbons 22,23 are turned, both ribbons 22,23 are travelling towards the folder with the lower ribbon 22 beneath the upper ribbon 23 as is required. The turner bars 26,27 are mounted in a turner bar module 26a above each print unit 1 (see Figure 1 and 2).

It will be appreciated that because the print unit is arranged so that the plane of the web is at an angle when it exits the print unit relative to the plane of the web as it enters the folder, all the ribbons rather than just some of them must be turned. Furthermore, all of the ribbons are turned the same number of times so that the tension between each of the ribbons can be controlled and maintained substantially equal.

It will be appreciated that the aforementioned embodiment relating to an arrangement of a printing press can be used in conjunction with none, some or all of the previously described embodiments to provide a particularly flexible printing press. Some examples of proposed printing press layouts incorporating all the aforementioned embodiments will now be described with reference to Figures 11 to 13 of the accompanying drawings.

Referring to Figure 11, there is shown a plan view of a possible printing press configuration which embodies all aspects of the invention namely, the retractable modules on each printing unit, the movable and replaceable primary modules, the removable and replaceable lower folder modules and delivery modules and the alteration of the orientation of each printing unit relative to the folder.

There is shown in Figure 11 a press having four printing units marked C1 and a folder marked F1. Each printing unit C1 has a pair of secondary modules indicated by the letter "I" to which are mounted the inking and dampening systems 5,6. These are shown in a position following separation from primary modules C1. Each print couple in each of the printing units is provided with its own motor 30. Only the motor 30 driving the uppermost pair of print couples can be seen in the drawing. The inking and dampening systems 5,6 of the secondary modules I are also each provided with their own motor 31 and again, only the uppermost motor of each secondary module I can be seen in the plan view of Figure 11.

It will be appreciated that the printing units are arranged in accordance with the aspect of the invention described with reference to Figure 5 so that the web passes

vertically upward through each print unit in a plane at right angles to the plane in which the web lies as it passes downwardly into the folder F1.

On the left hand side of the folder F1 beyond two of the printing units as viewed in the drawing, there is shown a row 32 of four additional primary modules each stored in an off-line position. These are marked C2 and C3. Any one of these modules may take the place of one of the primary modules C1 on the left hand side of the folder F1. The primary module C1 which is to be replaced may be moved into an off-line position in the row in the place indicated by dashed lines which is also marked C1. A similar row 33 is shown on the right hand side of the folder as viewed in the drawing. The dashed lines 33 between the primary modules C1 and the primary modules stored off-line marked C2 and C3 are symbolic of a track or slideway along which the primary modules may be moved between their storage positions and operational positions between the secondary modules using an automatic or manual transportation system.

A second similar configuration is illustrated in Figure 12 except that, in this drawing, the primary modules are stored off line in two rows 32a,32b at either end of the press. This arrangement may be more appropriate when the width of the press room is not sufficient to accommodate a single storage row 32.

It will be appreciated that the storage facility for the primary modules situated off – line may be separated from the press room by a dividing wall with an opening therein to allow movement of the primary modules to and from the press. This enables the modules to be plated up or otherwise worked on in a controlled environment different to the environment occupied by the working press.

In Figures 11 and 12, it can be seen that folder F1 includes an additional folder module 38 stored in an off-line location. This module 38 can replace the folder module currently in an operative position in folder F1 to facilitate cut-off change of the folder cylinders in a similar way to replacement of the primary modules C1 of each printing unit. Folder module can be moved to the off-line position indicated by dashed lines when replaced with the additional folder module 38.

Yet another possible configuration is illustrated in the cross-sectional view of Figure 13. In this arrangement, instead of providing the storage facilities for the primary modules at floor level, the primary modules are stored at a lower or sub-level basement area 34. It is envisaged that the modules C1, C2, C3 may be mounted on a slideable carousel or turntable 35 movable in the direction of arrow S so that a required primary module C1 is positioned between but below the secondary modules I. The primary module can then be winched up or hoisted into position between the secondary modules I in the direction of arrow T. The reelstand 36, which is normally mounted directly beneath the print unit, is offset in this configuration in order to allow sufficient space to accommodate the stored primary modules C1,C2,C3.

It will be appreciated from the foregoing that each aspect of the invention provides an advantage which may be used independently or together in a printing press to provide a flexible, easy to maintain and install system that can be used for high volume commercial printing, such as in the printing of newspapers.

Many modifications and variations of the invention falling within the terms of the following claims will be apparent to those skilled in the art and the foregoing description should be regarded as a description of the preferred embodiments only.

Claims

1. A printing unit for a web-offset press comprising plate and blanket cylinders arranged in couples to print on both sides of a paper web passing between each pair of print couples, and an inking system associated with each print couple when the printing unit is in an operative position operable to supply ink to the plate cylinder thereof, wherein the printing unit is separable into a primary module carrying the plate and blanket cylinders and a pair of secondary modules carrying the inking systems.

2. A printing unit according to claim 1, wherein the primary module is disposed between the pair of secondary modules.

3. A printing unit according to claim 1 or claim 2, wherein at least one of the secondary modules is slideable laterally away from the primary module to separate the printing unit into said primary and secondary modules.

4. A printing unit according to claim 3, wherein both the secondary modules are slideable laterally away from the primary module in opposite directions.

5. A printing unit according to claim 3, wherein one secondary module and the primary module are slideable laterally away from the remaining secondary module in the same direction.

6. A printing unit according to any preceding claim, including means to enable the primary module to be replaced with a different primary module when the or each printing unit has been separated so that each inking system of the secondary modules will be associated with a respective print couple of said different primary module when the or each printing unit is returned to its operative position.

7. A printing unit according to claim 6, including at least one additional primary module to replace the primary module disposed between the pair of secondary modules.

8. A printing unit according to claim 7, including a plurality of additional primary modules, said means enabling the primary module to be replaced with any of said plurality of different primary modules.

9. A printing unit according to claim 8, wherein said means enables the primary module and the or each additional primary modules to move laterally in a direction substantially at right angles to the lateral direction of movement of the secondary modules.

10. A printing unit according to any of claims 6 to 9, wherein said means to enable the primary module to be replaced with a different primary module includes a track, the primary module and the or each different primary module being movably mounted on the track.

11. A printing unit according to claim 10, wherein each primary module includes at least one drive motor or other means for driving said primary module along the track.

12. A printing unit according to any of claims 6 to 11, wherein the plate and blanket cylinders of each primary module have a different diameter.

13. A printing unit according to any preceding claim, wherein dampening systems are mounted to each of the secondary units.

14. A method of reconfiguring a printing unit comprising plate and blanket cylinders carried by a primary module and inking systems carried by a pair of secondary modules, an inking system being associated with each print couple when the printing unit is in an operative position, the method comprising the steps of separating the secondary modules from the primary module and replacing the primary module with a different primary module.

15. A method according to claim 14, wherein the method includes the step of moving the primary module in a lateral direction from between the secondary

modules to an off-line position when the secondary modules have been separated from the primary module.

16. A method according to claim 15, wherein the method includes the step of moving said different primary module to between the secondary modules and returning the secondary modules to their positions prior to separation from the primary module so that said inking systems are associated with each print couple of said different primary module.

17. A method according to claim 14 or 15, wherein the plate and blanket cylinders of each primary module have a different diameter.

18. A folder for a web-offset printing press comprising an upper folder module including at least one former to impart a first longitudinal fold to a continuous web of printed matter passing over the or each former, a lower folder module to receive the folded web from the upper folder module and comprising means to cut the web into longitudinal sections and impart a second fold to each section substantially at right angles to the first longitudinal fold and, a delivery module comprising means to receive the folded sections from the lower folder module and deliver them for transportation out of the folder, wherein the lower folder module is discrete and separable from the upper folder module.

19. A folder according to claim 18, wherein the lower folder module comprises a frame to which said means are mounted, the frame including cooperating means to releasably attach it to the upper folder module in an operative position.

20. A folder according to claims 18 or 19, wherein the lower folder module is a jaw folder and comprises a collect cylinder, a jaw cylinder and a cutting cylinder.

21. A folder according to any of claims 18 or 19, wherein the lower folder module is a rotary folder module and comprises a folding cylinder, second fold rollers and a cutting cylinder.

22. A folder according to claim 21 or 22, wherein the diameter of the respective cylinders of each lower folder module are different.

23. A folder according to any of claims 18 to 22, wherein the frame includes means to enable the lower folder module to be moved from its operative position to an off-line storage position.

24. A folder according to claim 23, wherein said means for moving the lower folder module includes means to enable a different lower folder module to be located in said operative position in place of the lower folder module.

25. A folder according to claim 23 or 24, wherein the folder includes at least two lower folder modules, each module movable between the operative position in the folder and an off-line storage position.

26. A folder according to any of claims 18 to 25, wherein the delivery module is discrete and separable from the lower folder module.

27. A folder according to claim 26, wherein the delivery module comprises a frame and cooperating means to releasably attach the frame to the lower folder module in an operative position.

28. A folder according to any of claims 18 to 27, wherein the means in the delivery module to receive the folded sections from the lower folder and deliver them for transportation out of the folder comprises a rotatably mounted paddle wheel.

29. A folder according to claim 28, wherein the delivery unit further comprises a stripper and a delivery conveyor to receive folded sections from the paddle wheel and transport them from the folder.

30. A folder according to claim 28 or 29, wherein the paddle wheel is rotatably driven by its own motor.

31. A folder for a web-offset printing press comprising an upper folder module including at least one former to impart a first longitudinal fold to a continuous web of printed matter passing over the or each former, a lower folder module to receive the folded web from the upper folder and comprising means to cut the web into longitudinal sections and impart a second fold to each section substantially at right angles to the first longitudinal fold and, a delivery module comprising means to receive the folded sections from the lower folder module and deliver them for transportation out of the folder, wherein the delivery module is discrete and separable from the lower folder module.

32. A folder according to claim 31, wherein the delivery module comprises a frame and cooperating means to releasably attach the frame to the lower folder module in an operative position.

33. A folder according to claim 31 or 32, wherein said means comprises a rotatably mounted paddle wheel.

34. A folder according to claim 33, wherein the delivery module further comprises a stripper and a delivery conveyor to receive folded sections from the paddle wheel and transport them from the folder.

35. A folder according to claim 33 or 34, wherein the paddle wheel is rotatably driven by its own motor.

36. A folder according to claim 35, wherein the motor is mounted to the delivery module.

37. A method of reconfiguring a folder for a web-offset printing press comprising an upper folder module including at least one former to impart a first longitudinal fold to a continuous web of printed matter passing over the or each former, a discrete lower folder module separable from the upper folder module to receive the folded web from the upper folder module and comprising means to cut

the web into longitudinal sections and impart a second fold to each section substantially at right angles to the first longitudinal fold and, a delivery module comprising means to receive the folded sections from the lower folder module and deliver them for transportation out of the folder, wherein method includes the step of separating the lower folder module from the upper folder module and replacing the lower folder module with another lower folder module.

38. A printing press including a plurality of printing units according to any of claims 1 to 12.

39. A printing press including a folder according to any of claims 18 to 36.

40. A printing press including a plurality of printing units according to any of claims 1 to 12 and a folder according to any of claims 18 to 36.

41. A method of reconfiguring a printing press comprising the method steps according to any of claims 14 to 17 and the method of claim 37.

42. A web-offset printing press comprising a print unit and a folder located adjacent to the print unit together defining a path for a web of paper passing through the press, the print unit comprising means for slitting the web to form a plurality of ribbons and means for turning said ribbons so that each lie in a parallel plane one above the other as they travel towards and into the folder, wherein the press is configured such that said means for turning the ribbons is operable to turn each ribbon the same number of times between the print unit and the folder.

43. A press according to claim 42, wherein the press is configured so that the web passing up through the print unit lies in a plane at right angles to the plane occupied by each of the ribbons as they pass down into the folder.

44. A press according to claim 42 or 43, wherein the printing unit comprises print and blanket cylinders arranged to rotate about first parallel axes and the folder

comprises cylinders arranged to rotate about second parallel axes, the first and second axes being at right angles to each other.

45. A printing unit substantially as hereinbefore described with reference to Figures 1 to 3, 5, 6 and 8 to 11 of the accompanying drawings.

Abstract

Printing Unit

A printing unit for a web-offset press is disclosed. The printing unit comprises plate and blanket cylinders arranged in couples to print on both sides of a paper web passing between each pair of print couples, and an inking system associated with each print couple when the printing unit is in an operative position operable to supply ink to the plate cylinder. The printing unit is separable into a primary module carrying the plate and blanket cylinders and a pair of secondary modules carrying the inking systems. Other aspects of the invention include a printing press and a folder unit for use in a printing press.

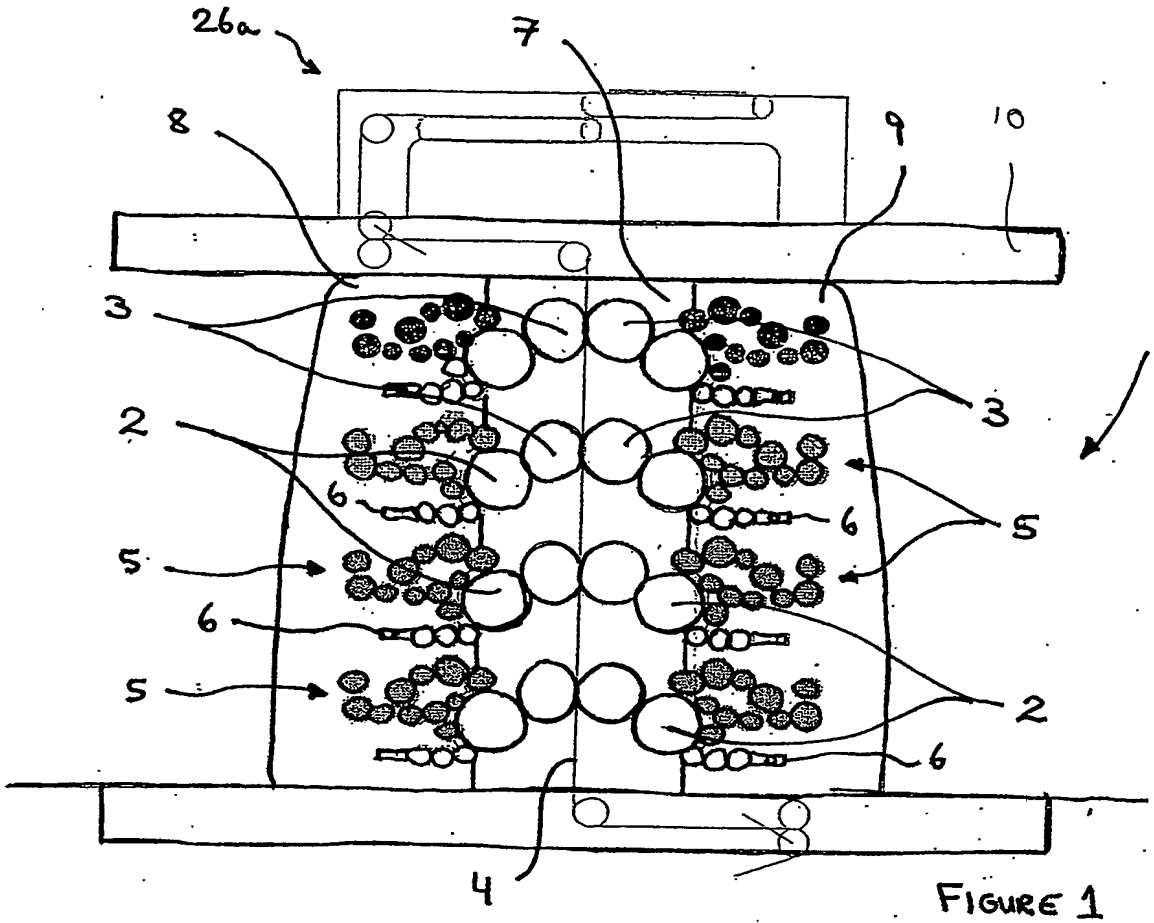


FIGURE 1

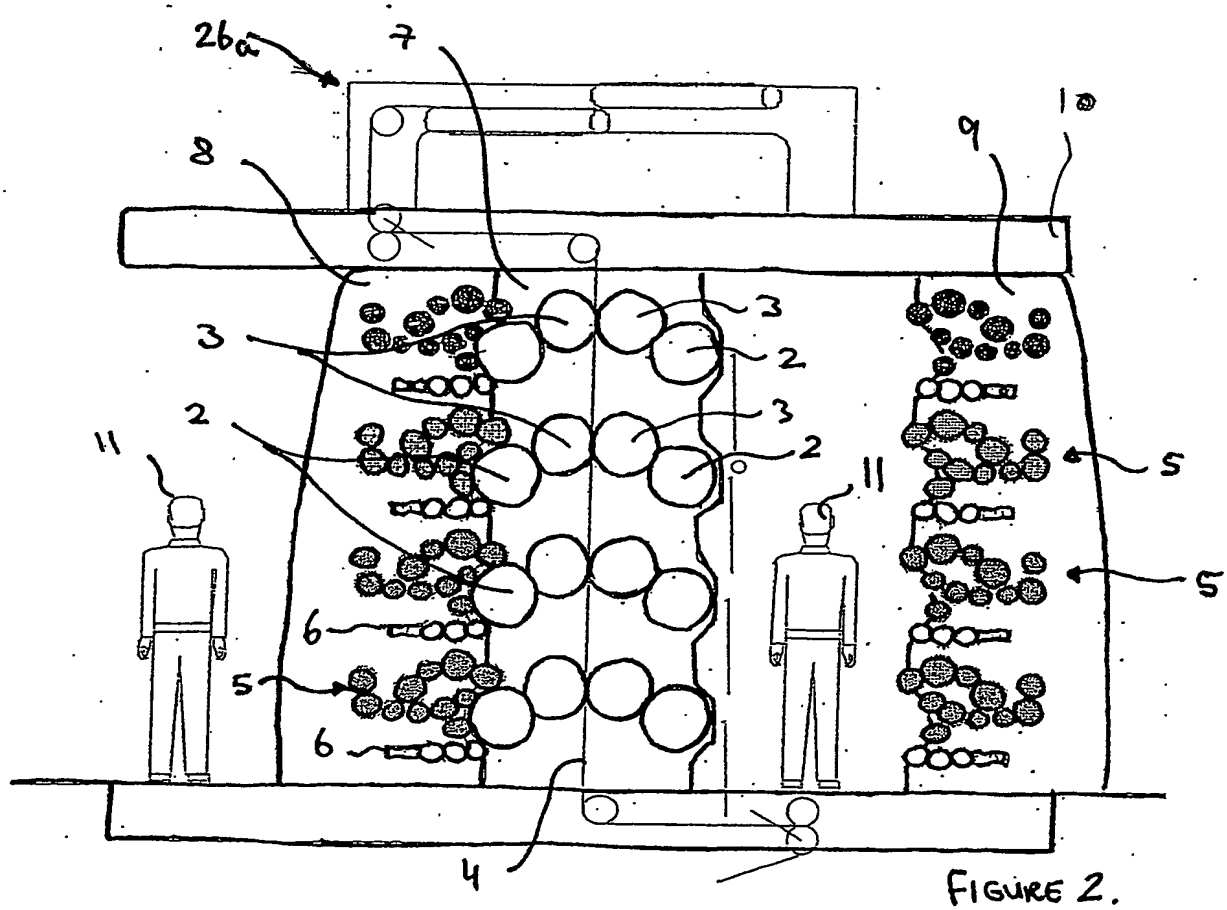


FIGURE 2.

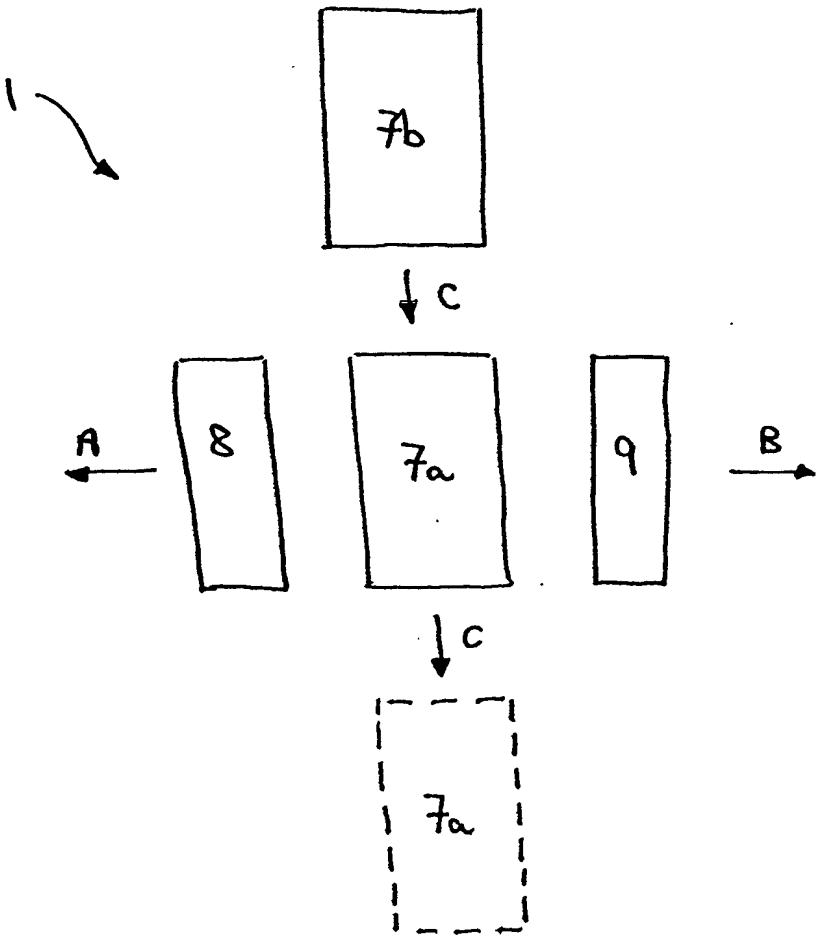


FIGURE 3.

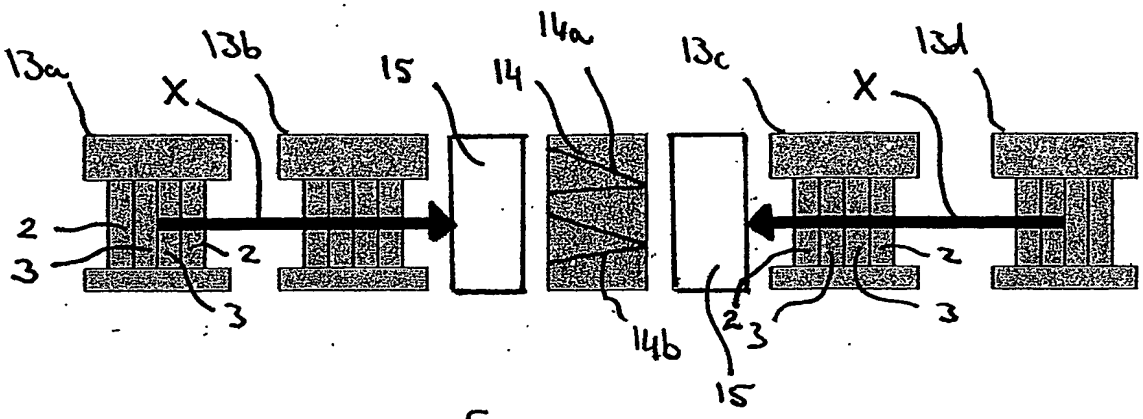


FIGURE 4
(PRIOR ART)

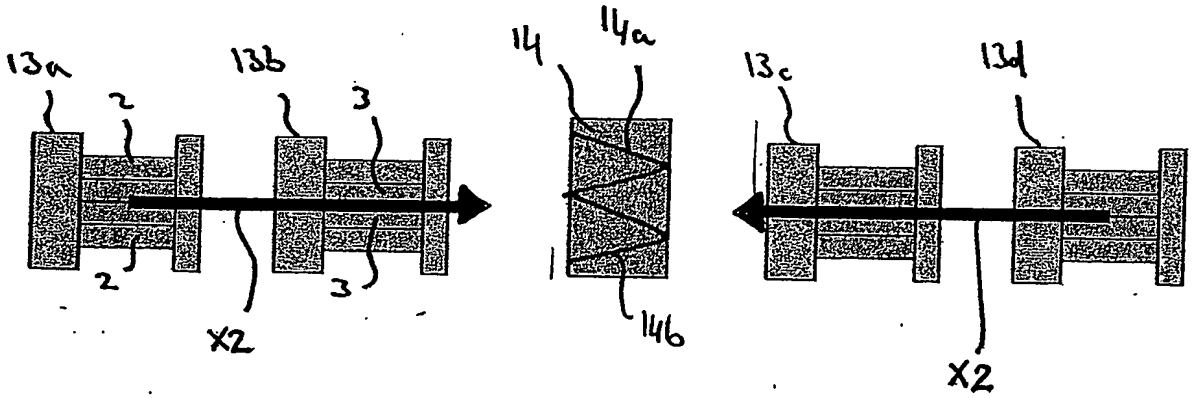


FIGURE 5

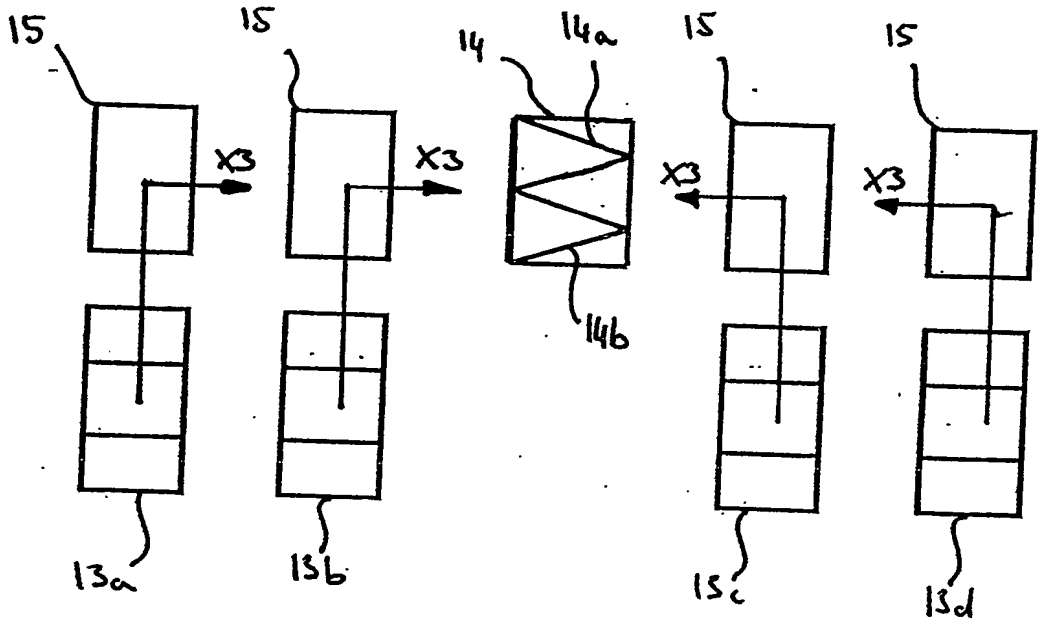


FIGURE 6

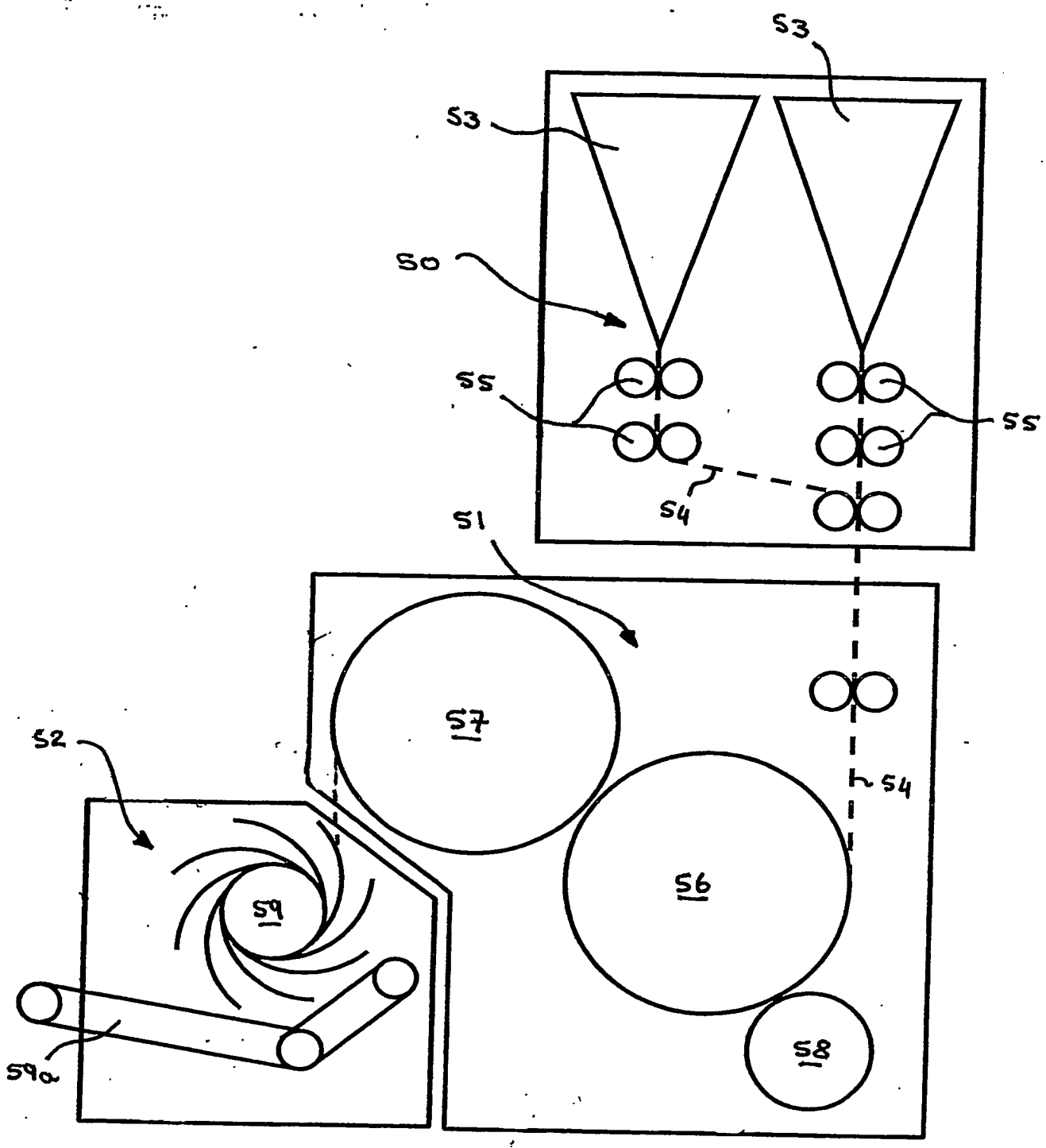


FIGURE 7

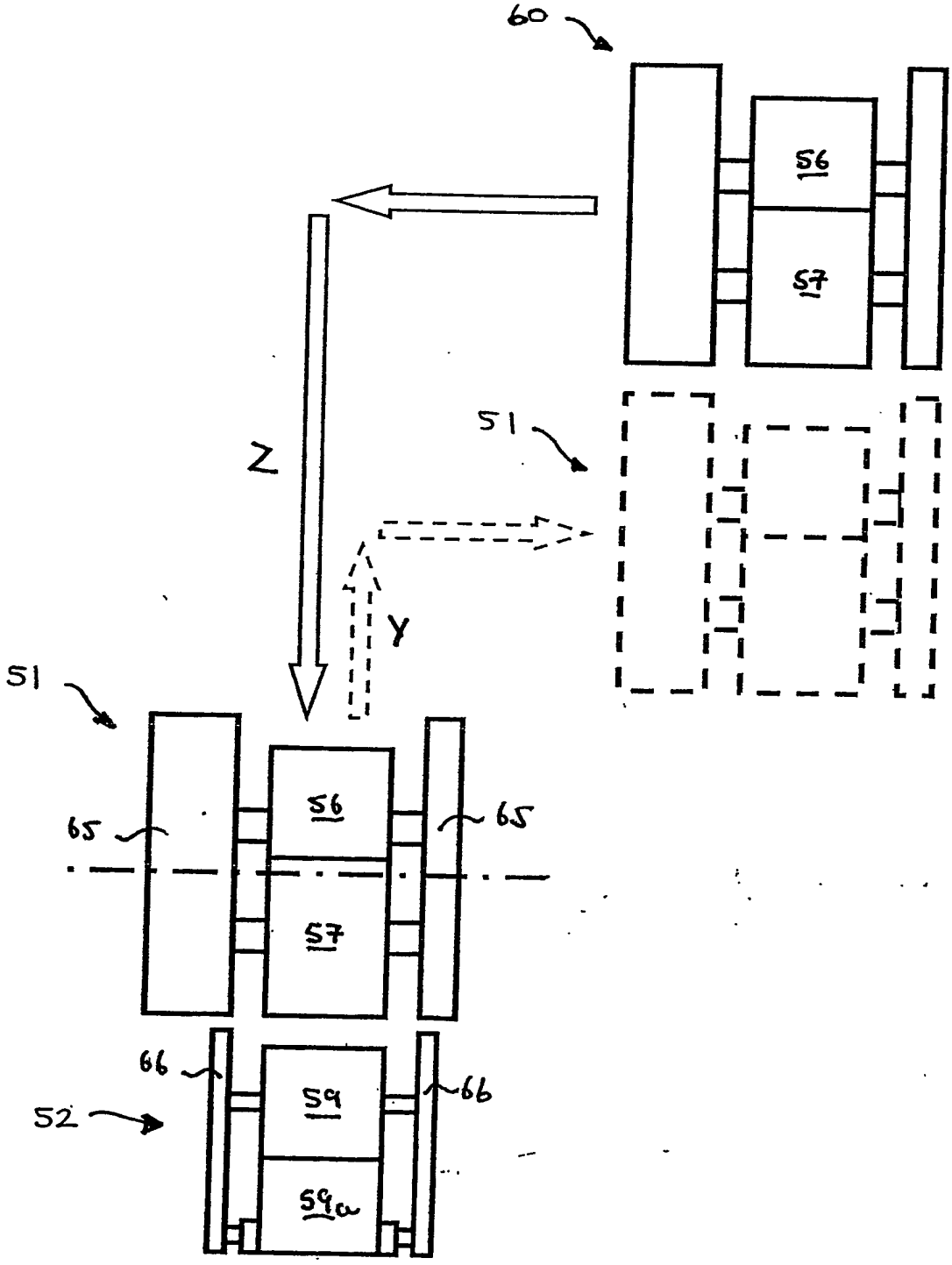


FIGURE 8.

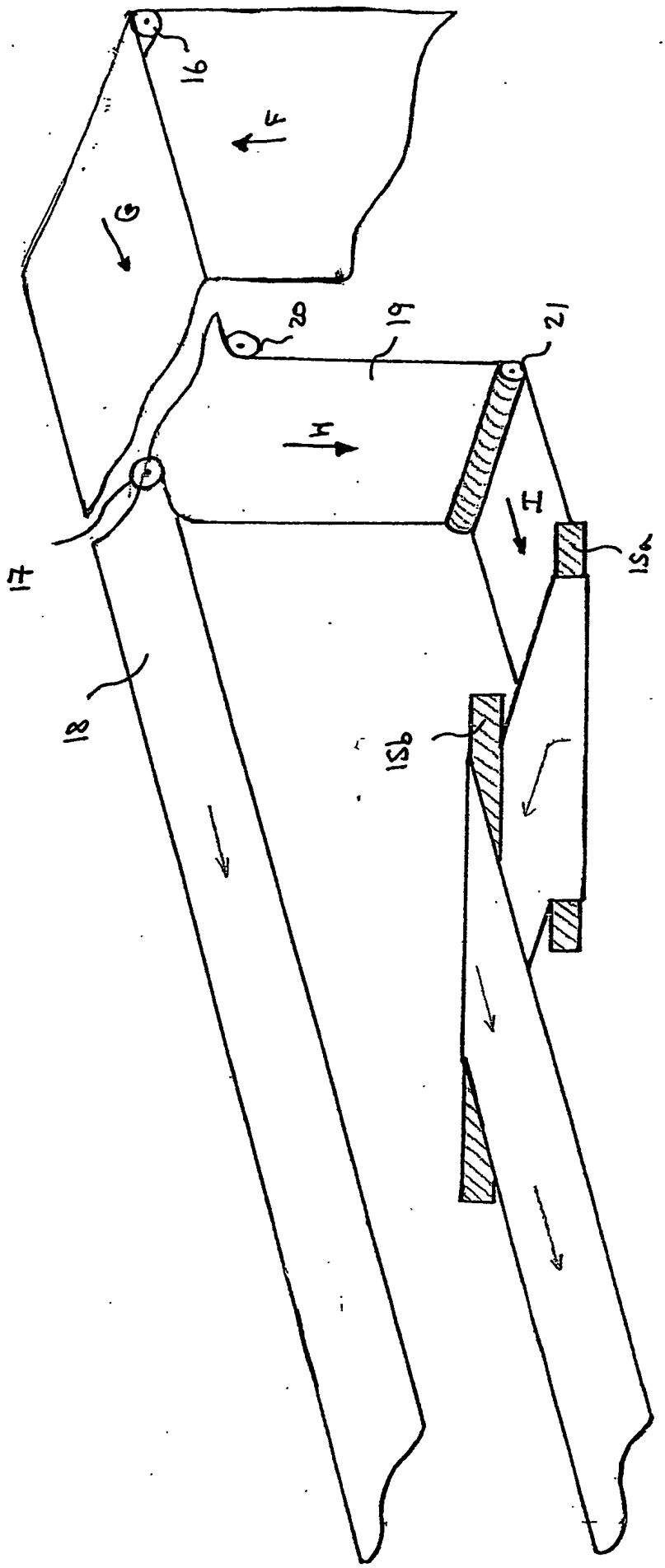


FIGURE 9
(PRIOR ART)

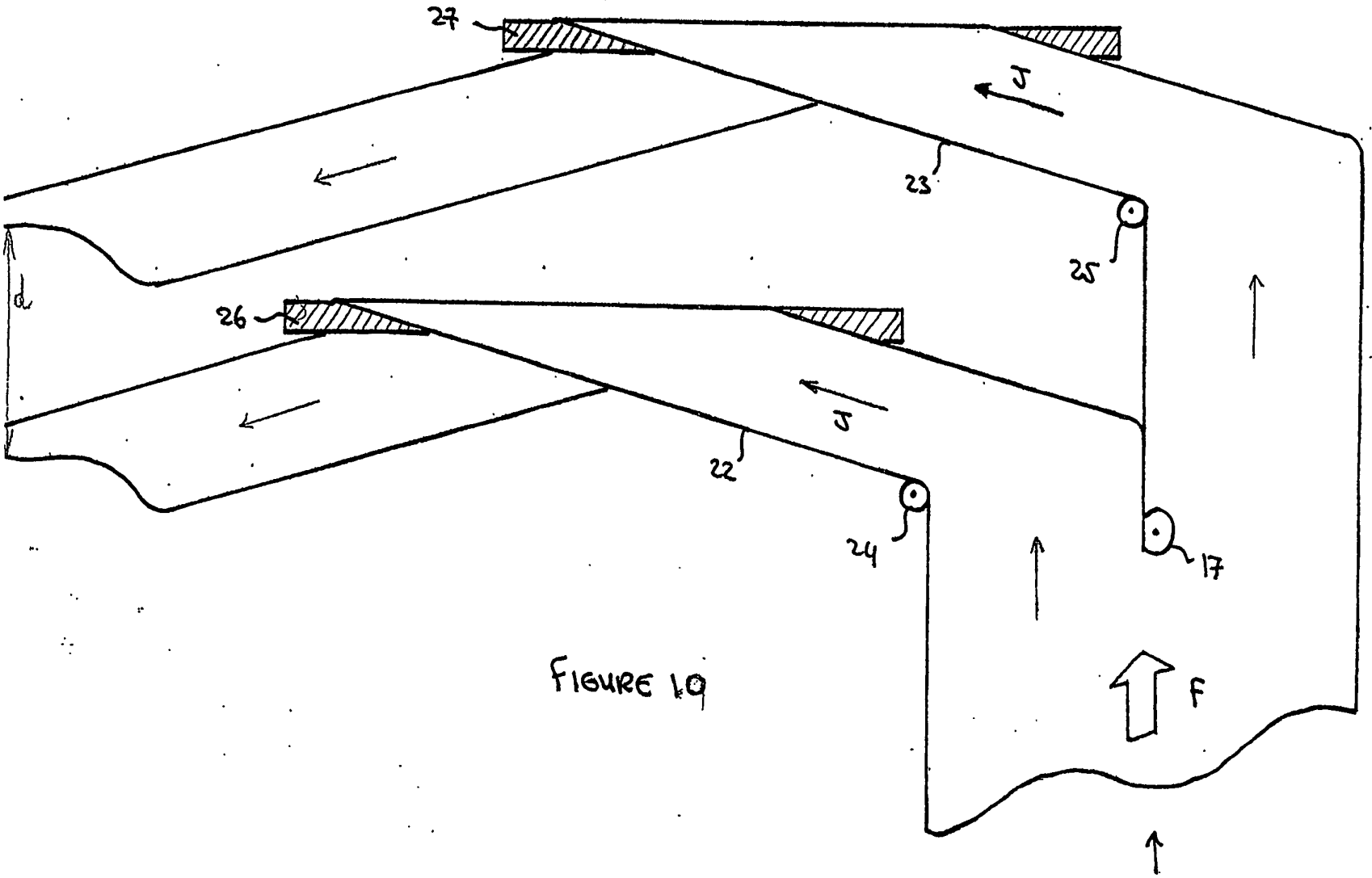
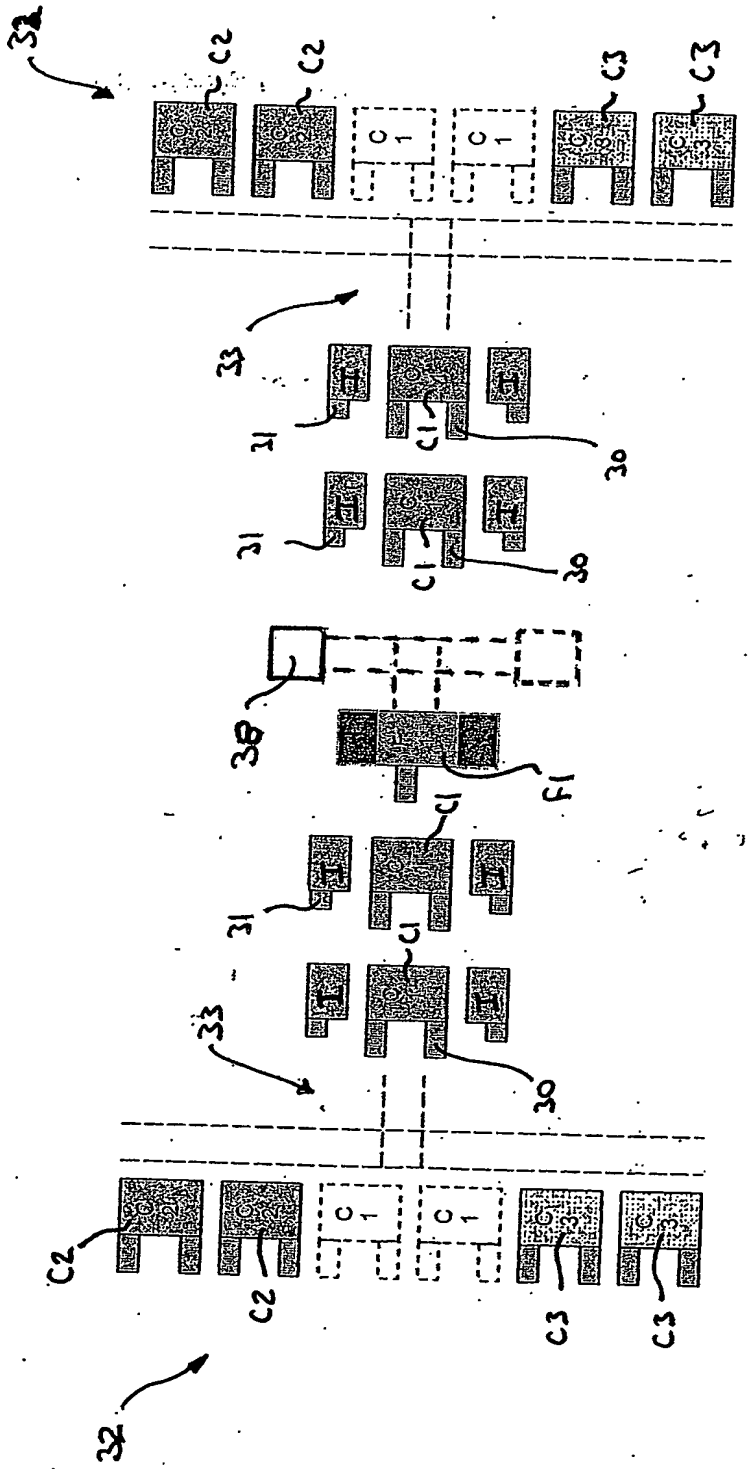


FIGURE 19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C1
C1
C3
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31
C1
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31
C1
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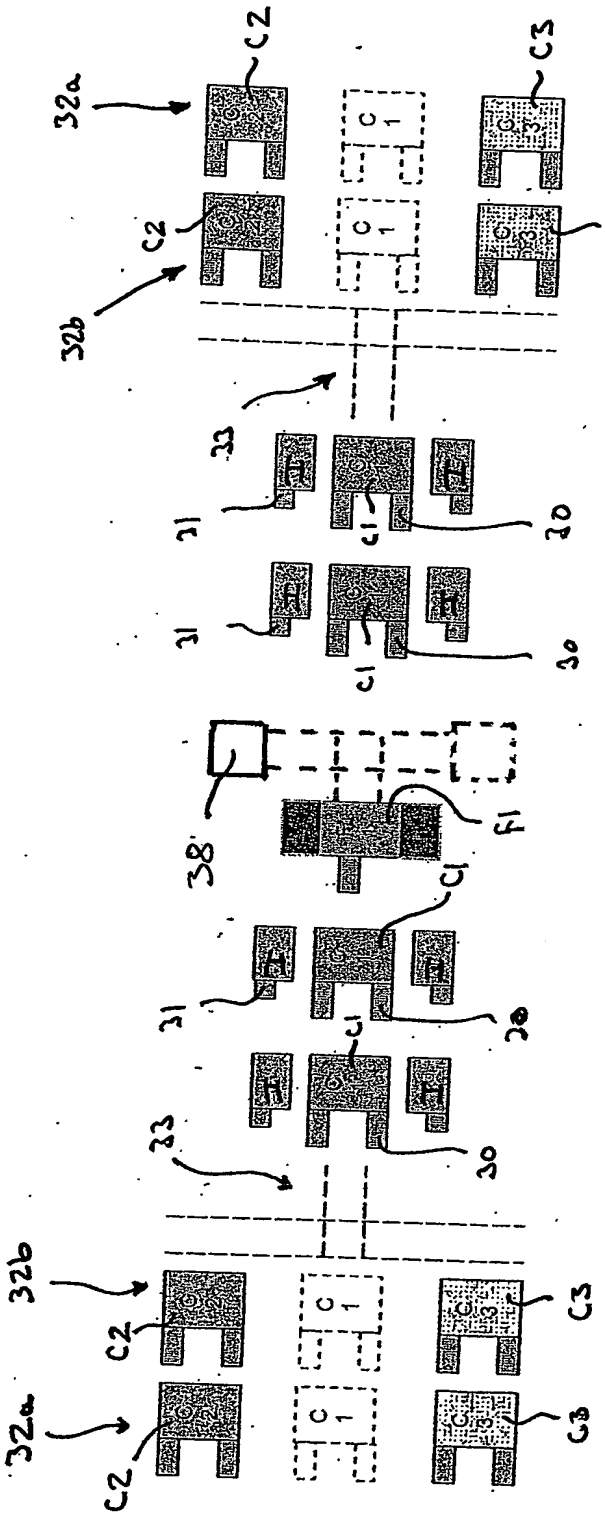
33
30
C2
C2
C1
C1
C3
C3
32

Figure 11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C2
C3
C1
32b
C2
C3
33
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C1
31
30
C1
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32b
C2
C3
32a
C2
C3

Figure 12.

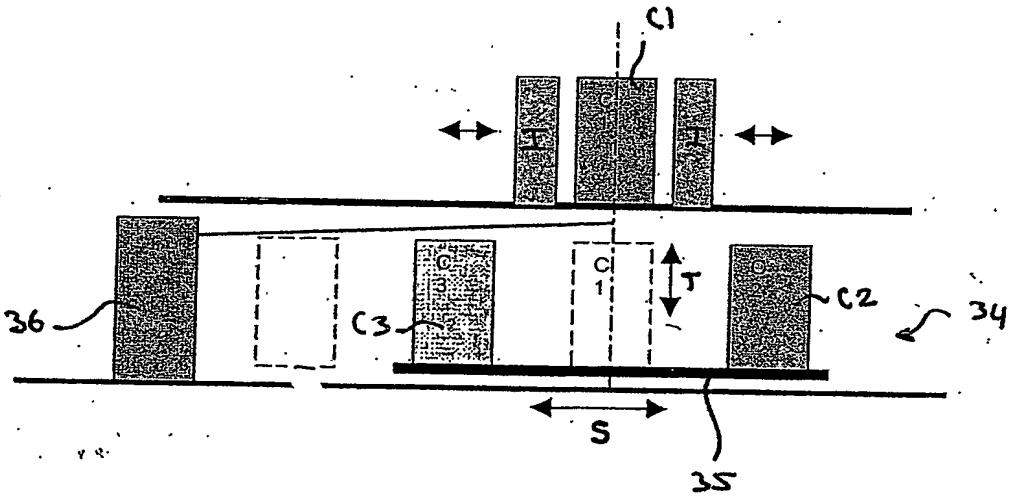

FIGURE 13